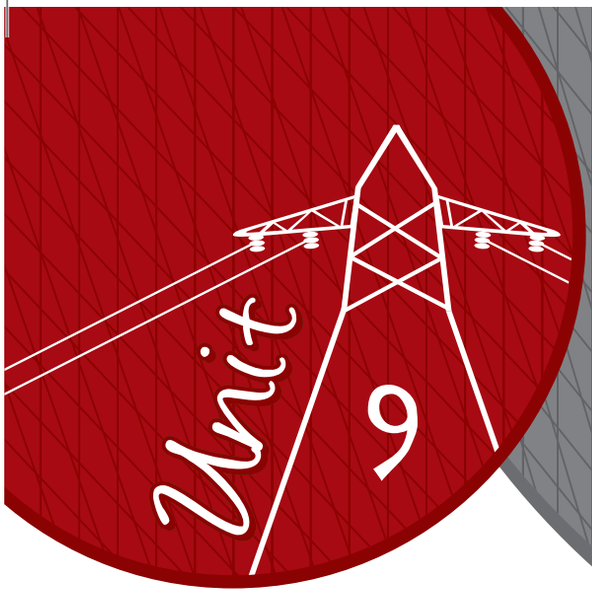

Wire Preparation Methods

Introduction

Wire preparation is done through cutting, stripping, slitting, marking, crimping, and so on based on electrical connection, length accuracy, cross sectional width and amperage. The tools required for this purpose are different type of wire strippers, wire cutters, and so on. Electrical wiring must be installed in accordance with the electrical regulations and safety standards. If electrical wiring is carried out incorrectly or without adhering to the required safety standards, devices may get damaged and it may also lead to reduced device durability.

The following points must be considered for wire preparation.

- Choose a wire depending on the colour code mentioned by various standards, such as red for phase wire, black for neutral, green for earth, and so on.
- Various electrical tools are required for installation work. Some of these tools include cutters, strippers, testers, pliers, etc.
- Choose the components, such as electrical boxes, switches and receptacles based on their size and rating.

Wire conductors are available in many forms, ranging from single solid insulated conductors to highly integrated multiple conductors. Different type of tools are needed for preparing different kind of wires.

Wire preparation steps

In an electrical network, wiring plays an important role. Therefore, a wireman must know the steps for wiring installation. The basic step for wiring is wire preparation. Wire preparation includes the basic techniques and tools, which must be used for wiring. Wiring process relates to the preparation of wires or cables. The following steps need to be considered for wire preparation.

- Wire stripping
- Wire cutting
- Wire marking

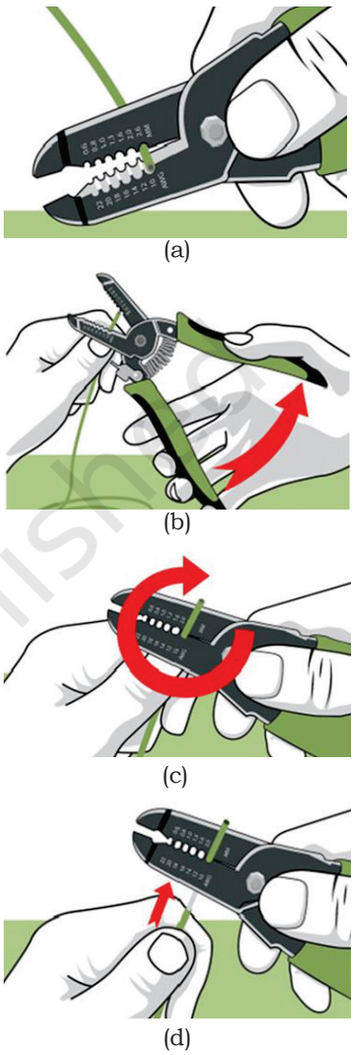

Fig. 9.1 (a–d) Insulation removal steps

Wire stripping

Electric wire is coated with an insulating material. The wire inside the insulating material consists of a metal conductor, which carries the current. Insulation removal is an essential step of wire preparation. Stripping is the process of removing the insulation. Stripper is a hand tool used to remove wire insulation. There are several techniques that are used to strip the insulation of wires. There are various type of wire strippers available in market for insulation removal. Fig. 9.1(a–d) shows the steps to remove wire insulation with the help of a stripper.

Hand-operated strippers are of several types, such as

- adjustable,
- hand-held automatic, and
- non-adjustable

Adjustable hand stripper

This tool uses V-shaped jaws for cutting the insulation of a wire. It is like a pair of scissors with a little notch to cut the insulation. There is a stop screw that can be adjusted back and forth. By adjusting the screw

Fig. 9.2(a) Adjustable hand stripper

Fig. 9.2(b) Different sections of an adjustable hand stripper

Fig. 9.3(a) Hand-held automatic stripper

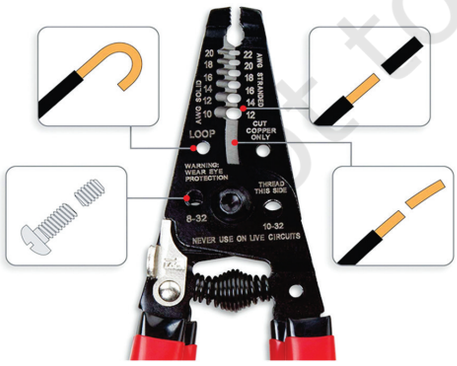

Fig. 9.3(b) Different sections of a hand-held automatic stripper

the jaws can be opened according to the wire size. The screw should be moved in such a way that only the insulation of the wire gets cut and not the conductor. Adjustable screw allows the hand stripper to cut wires of various diameters. Fig. 9.2(a) shows an adjustable hand stripper. Use a piece of wire to test whether the jaws of the hand stripper are appropriately adjusted or not. After removing the insulation, check if any damage is caused to the wire.

An adjustable hand stripper contains three sections, which are as follows.

- The first section is used for stripping the wire.
- The second is used for cutting the wire.
- The third is used for bending the wire.

Hand-held automatic stripper

The word automatic denotes the self-adjusting feature of the stripper. In an automatic stripper, there is no need to move the screw manually to adjust the opening of the jaws. The automatic stripper has predefined holes as per the gauge standard of a wire. Wire that has to be stripped has some standard gauge. This wire is inserted in the appropriate hole, having the same gauge value of automatic stripper. Use the apt size of the cutting hole when using a hand-held automatic stripper as shown in Fig. 9.3(b). A hand-held automatic stripper contains various sections, which are as follows.

- One section is used for stripping the wire.
- One section is used for cutting the wire.
- One section is used for making threads in the bolts.
- One section is used for bending the wire.

Non-adjustable stripper

This tool can be adjusted according to the length of the wire to be stripped. The jaws are designed

in such a way that they can grip the insulation of the wire without leaving any mark on it as shown in Fig. 9.4(b).

Fig. 9.4(a) Non-adjustable stripper

Fig. 9.4(b) Stripping a wire using a non-adjustable stripper

Wire cutting

Sometimes there is a need to cut the wire to get the required length, which means the wire is first cut, and then, stripped to connect to the components. A wire cutter is used for cutting the wire. Fig. 9.5 shows wire cutting.

Fig. 9.5 Wire cutting

Wire marking

Wires are marked with different colours (Fig. 9.6). Colours indicate the purpose for which the wires are to be used. They must also be labeled to provide indications of their usage and other safety information.

Fig. 9.6 Wire marking

Cable stripper

Wires, usually, have a small diameter. This limits the range of transmission and distribution. A wire with a small diameter can carry only a small amount of current in its conductor. For high current and voltage transmission, a thick conductor with a thick layer of insulation is required. The conductor and insulation combine to form a cable. Different type of cables are available in market. They have more than one protective layer. These layers play an important role at the time of stripping.

Stripping of cables is done by a cable stripper. The outer coating of multicore cables needs to be removed without damaging the inner core. There is a spring in

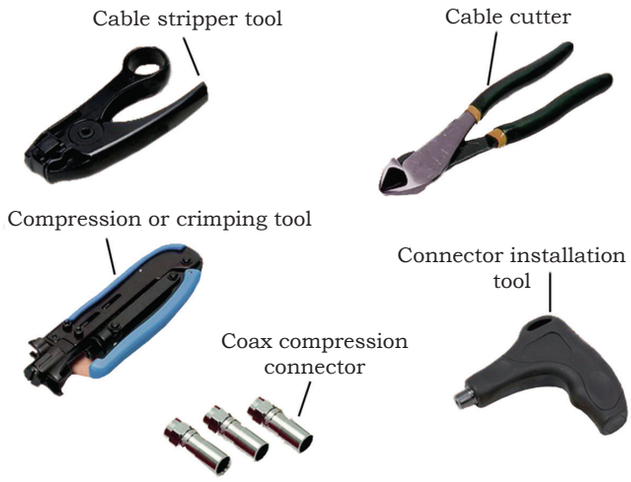

Fig. 9.7 Tools required for stripping a cable

the cable clamp and the cutter can be adjusted according to the thickness of the outer sheath.

Cable stripping operation

The steps to strip a cable are as follows.

Step 1

In order to strip a cable, the following tools are required as shown in Fig. 9.7.

Coax compression connector

There are several type of connectors available. Compression connectors provide the best connection and finish to a cable. Another type of connectors are 'crimp' connectors. Avoid using push-on or twist connectors.

Compression or crimping tool

It is used to crimp the connectors mounted on the conductor. Ensure that it is compatible with the compression or crimping connector.

Cable stripper tool

It is used to strip the insulation of coaxial cable.

Cable cutter

It is used to cut the cable insulation and conductor.

Connector installation tool

This tool is used for pushing the connector firmly onto the stripped cable.

Fig. 9.8 Cable cutter

Step 2

Use the cutting tool to make a straight cut at the end of a cable. After cutting, use fingers to push the end of the cable back into a circle (Fig. 9.8).

Fig. 9.9 Adjustable knob for stripper

Step 3

Adjust the stripper to work on the cable. If the wire stripper is not adjusted, the ground wire may get stripped, damaging the cable.

Step 4

Strip the end of the cable. Place the end of the cable into the stripper. Spin it around two to three times so that insulation at the end of the cable can be removed as shown in Fig. 9.10.

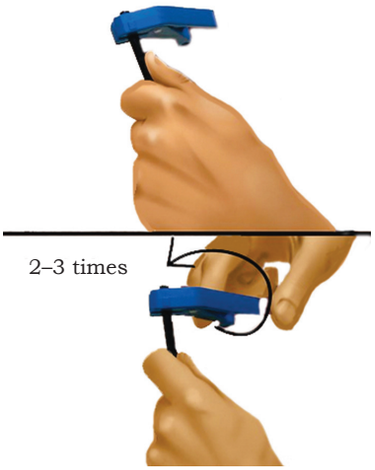

Fig. 9.10 Rotate the stripper for insulation removal

Step 5

Pull off the outer shield of the cable as shown in Fig. 9.11. After stripping the cable, two segment cuts can be seen. Pull the outermost segment off of the cable. This will reveal the centre conductor wire.

Step 6

Pull off the second segment or inner cut of the cable as shown in Fig. 9.12. This will reveal the foil that insulates the cable. Find the edge of the foil and peel it off the cable. This will leave a single layer of foil around the white insulation.

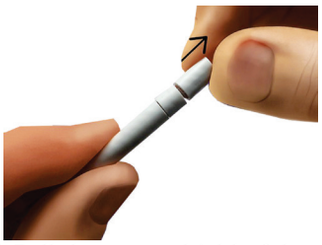

Fig. 9.11 Pull the outer shield of the cable

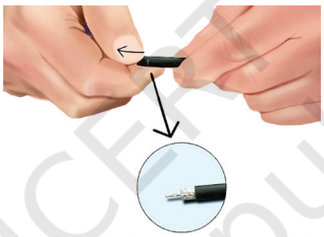

Fig. 9.12 Pull the inner cut of the cable

Fig. 9.13 Fold the ground wire of the cable

Step 7

When the cable jacket is pulled off, a lot of loose ground wires can be seen. Fold these back against the cable such that the connector touches all wires when installed as shown in Fig. 9.13.

Step 8

Cable stripper tools will leave the correct length of a conductor wire exposed but check before proceeding. Cut the conductor using a wire cutter, if necessary as shown in Fig. 9.14.

Fig. 9.14 Cut the wire using a wire cutter

Step 9

Insert a connector into the stripped end of the cable conductor as shown in Fig. 9.15.

- Avoid bending the bare conductor wire when installing the connector.
- Twist the cable while pushing with the tool to connect it firmly.

Fig. 9.15 Insert a connector in the cable conductor

Fig. 9.16 Crimp the connector using a cable crimper

Step 10

Compress or crimp the connector. The process for compressing or crimping the connector varies, depending on the type of connector being used. Some require press down on the cable end of the connector piece, while others require pushing the front end of the connector piece into each other as shown in Fig. 9.16.

Fig. 9.17 Cable after crimping

Step 11

After compressing the connector, inspect it for loose connections. Loose connections can lead to poor signal or non-functional cable.

Damages during insulation removal

Some damages that may be caused at the time of removing insulation are:

- dents or scratches in solid conductors,
- stripped plating and scores in solid metal conductors and
- twisting of wire with other wires.

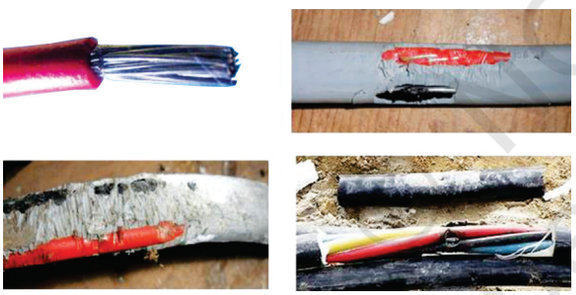

Fig. 9.18 Cuts in wires

Cuts in wire

Cuts weaken the wire mechanically and also reduce its current carrying capacity. Cuts hamper the functioning of an equipment as the wire gradually breaks. Cuts can also lead to electric shocks. Always put insulation tape over damaged wires. Fig. 9.18 shows some of the damages (cuts) that can occur during insulation removal.

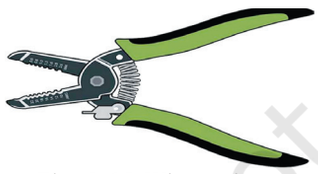

Fig. 9.19 Wire stripper

General principles of wiring and stripping of wire

A wire stripper has a number of notches in its jaws. It looks like a pair of pliers as shown in Fig. 9.19. Different types of wire and gauges can be put in the notches. These notches can vary in size.

Place the wire in the notch according to the size of wire, and then, gently close the jaws of the stripper. Line it up so that the jaws are about an inch (two to three centimetres) from the end of the wire as shown in Fig. 9.20.

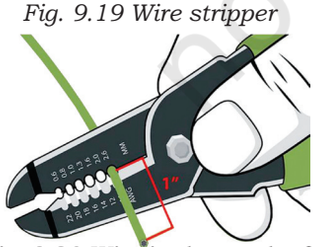

Fig. 9.20 Wire in the notch of a wire stripper

Use pressure to remove the insulation as shown in Fig. 9.21. Do not press too hard as it may damage the wire beneath the insulation, and hence, make it unsuitable for an electrical project. Use notch with the right gauge to cut the insulation without damaging it.

Fig. 9.21 Press the handles of the stripper to remove insulation

After closing the stripper's jaws around the wire, cut the circumference of the insulator by using the cutting tool. Carefully rotate the tool around the wire as shown in Fig. 9.22.

Keep the tool's jaws closed to slide it off the wire to remove insulation from the tip. Pull the tool towards the short end of the wire or the end that is only about an inch (two to three centimetres) away from the jaws as shown in Fig. 9.23.

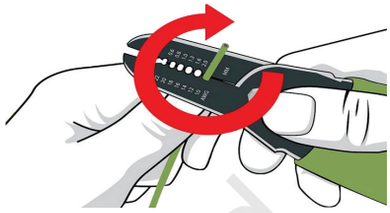

Fig. 9.22 Rotate the stripper around the wire

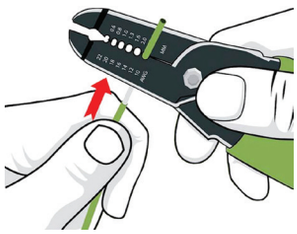

Fig. 9.23 Pull the insulation of wire

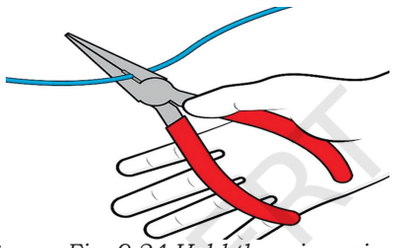

Fig. 9.24 Hold the wire using a pair of pliers

Fig. 9.25 Cut the damaged part of the wire

Hold the plier in one hand. Bring the wire to be stripped between its jaws and press its handles together to close the jaws as shown in Fig. 9.24.

Observe if the wire is twisted or broken. If so, then that part of the wire must be removed because it may cause discontinuity in carrying electricity. Use a wire stripper to cut the twisted and damaged part of the wire as shown in Fig. 9.25.

Wire insulation removal using utility knife

Place the wire on a flat work surface. Use one hand to hold the utility knife about an inch (2–3 cm) from one end of the wire. Do not do any cutting and let the knife rest on the exact spot you want to cut as shown in Fig. 9.26.

Fig. 9.26 Place a utility knife on the wire that needs to be cut

Hold the knife with one hand. Roll the wire with the other hand so that the blade scrolls all the way around the insulation sheathing as shown in Fig. 9.27. Do not press hard with the knife. Apply appropriate pressure for removing the insulation.

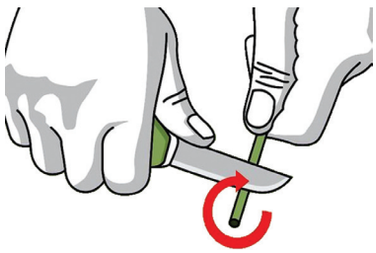

Fig. 9.27 Roll the wire with one hand

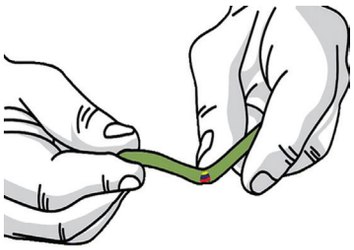

Fig. 9.28 Put a cut mark around the wire and bend it up and down to break

Put a cut mark around the insulation sheathing that needs to be removed. Bend the tip of the wire up and down to break as shown in Fig. 9.28. Slide off the insulation at the marked line.

Wire bending

- To bend the wire, mark it with a marker or pencil. A thicker wire may require larger tools and specialised machinery as shown in Fig. 9.29.
- For bending the wire at 90 degrees, use a pair of pliers with wide jaws as shown in Fig. 9.30.

Fig. 9.29 Marking on the wire for bending

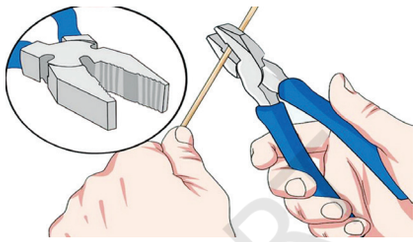

Fig. 9.30 Use a pair of pliers for bending the wire

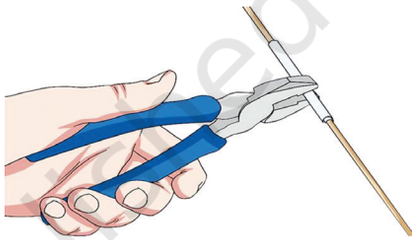

Fig. 9.31 Wrap a piece of cloth around the wire

- Grip the wirewith the pair of pliers. To prevent the wire from developing marks from the pliers, wrap a piece of cloth around it or grip it with two small pieces of wood on either side as shown in Fig. 9.31.
- Make the bend by turning the pliers to the direction needed as shown in Fig. 9.32.
- Another way to bend the wire is to use a vice. Use a block of wood to ensure even bending as shown in Fig. 9.33.

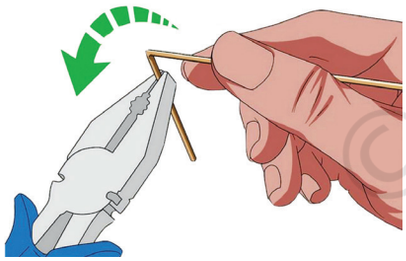

Fig. 9.32 Using the pair of pliers to bend the wire

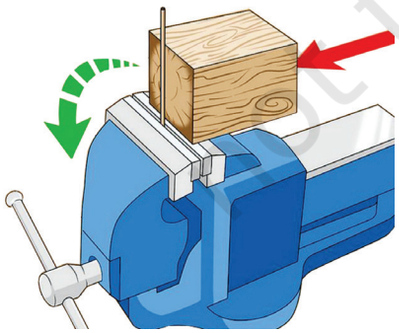

Fig. 9.33 Use a vice to bend the wire

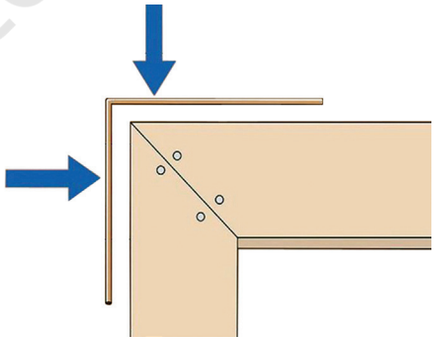

Fig. 9.34 Check for correct wire bending using a square frame

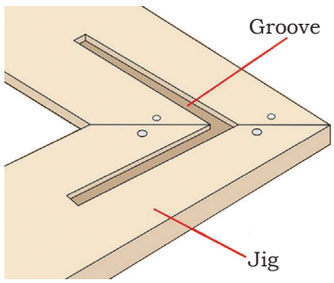

Fig. 9.35 Groove formation using a jig

- Check the angle of the wire using a square frame as shown in Fig. 9.34.
- Use a jig to form grooves on the wooden frame at 90 degrees as shown in Fig. 9.35. The simplest method to make one of these is to drill two crossing holes through a piece of wood. By cutting the wood at 90 degrees through the centres of the holes, you will end up with two pieces of wood with crossing grooves as shown in Fig. 9.35.

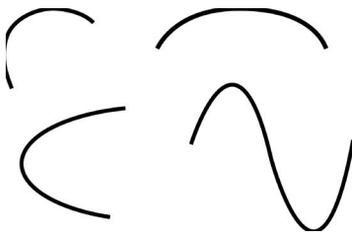

Fig. 9.36 Curves of different shapes

Making regular curves of wires

- A regular curve is a line, which follows the curvature of one specific circle as shown in Fig. 9.36.

Fig. 9.37 Free hand curve template

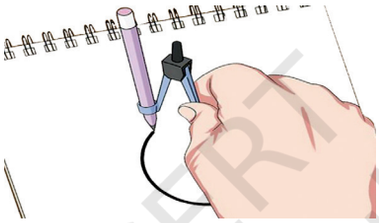

Fig. 9.38 Curve template drawn using a compass

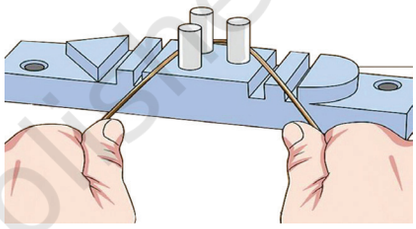

Fig. 9.39 Making a curve in a wire using a machine

- Make a template of circle or curve as shown in Fig. 9.37 and 9.38.
- To make the template, draw a curve on a paper and cut it. Now, put the paper template on a wooden or plywood board and cut as per the template to get the curve.
- Use specialised machines for bending wires and tubings as shown in Fig. 9.39.

Fig. 9.40 Observing the material of wire conductor

Straightening of wire

- A wire can be straightened in many ways, taking into account the properties of the wire as shown in Fig. 9.40.
- Straighten thin and soft wires by hand as shown in Fig. 9.41.
- Straighten thick and strong wires on an anvil or similar surface as shown in Fig. 9.42.

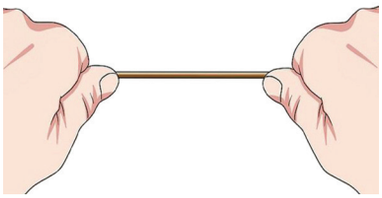

Fig. 9.41 Straightening the wire using hands

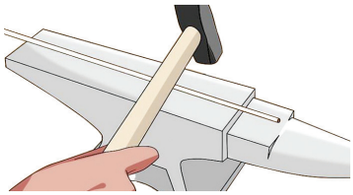

Fig. 9.42 Straightening the wire using a hammer

The hammer must be made of harder material than the wire. Use it gently as there is a risk of flattening or damaging the wire in the process. Wood or brass hammer is a good choice.

- Straightening thin and soft aluminium or copper wire is the easiest with two pieces of wood and a vice.
- Sandwich the wire between the wood and secure it in the vice. Do not put much pressure. It can be done by pulling the wire through the two pieces of wood as shown in Fig. 9.43.
- Another option is securing one end of the wire in a vice, and then, pulling along the wire with two pieces of wood.

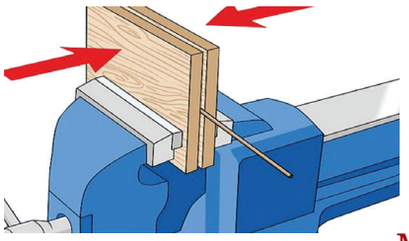

Fig. 9.43 Straightening the wire using wooden pieces

Making loop of wire

- Use pliers with round jaws (Fig. 9.44). Conical jaws will make nooses (loop) of varying diameter.
- Square pliers can be used to make square nooses.
- Choose the gripping point on the pliers according to the diameter of the noose (Fig. 9.45).
- Adjust the wire in the jaws of the round nose plier as shown in Fig. 9.46.
- After that, rotate the pliers so that the bent part is not gripped by the jaws as shown in Fig. 9.47.
- Repeat the previous step until the circle is complete as shown in Fig. 9.48.

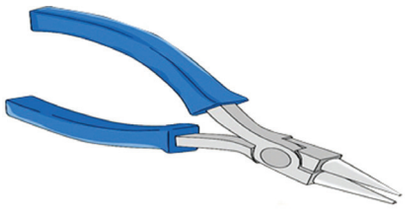

Fig. 9.44 Round nose plier

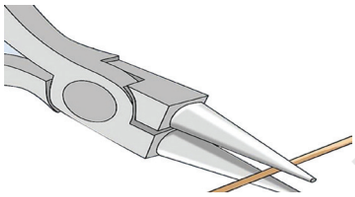

Fig. 9.45 Placing the wire in the round nose plier

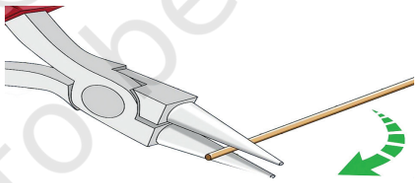

Fig. 9.46 Adjusting the wire in the jaws of round nose plier

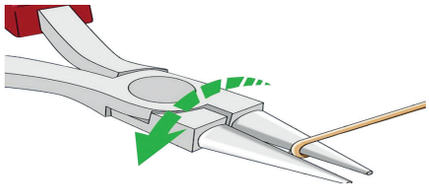

Fig. 9.47 Rotating the round nose plier

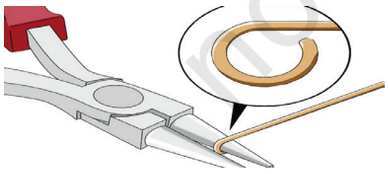

Fig. 9.48 Turning the wire in circular shape

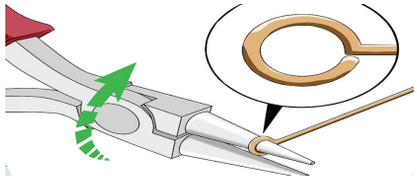

Fig. 9.49 Bending the noose of wire using a nose plier

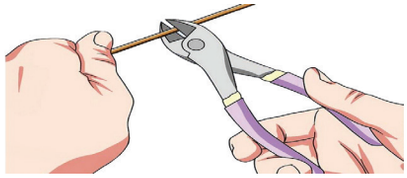

Fig. 9.50 Cutting the extra wire with a wire cutter

- Bend the noose back as shown in Fig. 9.49.
- Cut off the excess wire with the help of a wire cutter. A specialised chisel or a hacksaw can also be used as shown in Fig. 9.50.
- Make the end of the wire smooth. Make necessary adjustments to the noose as shown in Fig. 9.51.
- Flatten the noose to give it finishing touches it as shown in Fig. 9.52.

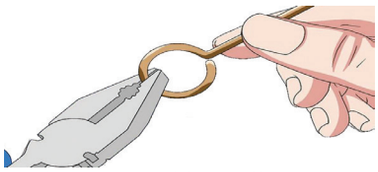

Fig. 9.51 Making adjustment in the noose using a pair of pliers

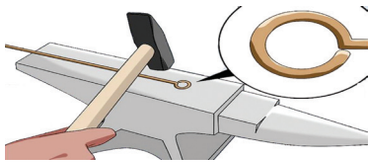

Fig. 9.52 Flattening the wire using a hammer

Wire joints

Western union joint

It is a straight joint used for small solid cables. To form a western union joint, the following points have to be considered.

- Remove the insulation.
- Bring the two conductor wires to a crossed position, and then, make a long bend or twist in each wire.
- Wrap the end of one of the wires around the straight portion of the other wires, and then, do the same for the other wire. Repeat this for about four to five times.
- Press the ends of the wires down close to straight portions of the wires to prevent the ends from intruding through the insulation tape (as shown in Fig. 9.53)
- Insulate the joint using the tape.

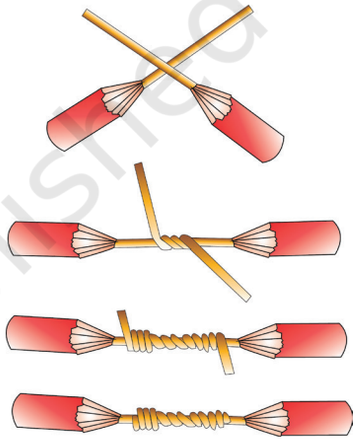

Fig. 9.53 Wire joints

Fixture joint

It is a type of branch joint, connecting a small diameter wire with a large diameter conductor, such as those used in lighting fixtures as shown in Fig. 9.54. To form a fixture joint, the following points have to be considered.

- Remove the insulation.
- Now, wrap the fixture wire around the branch wire.

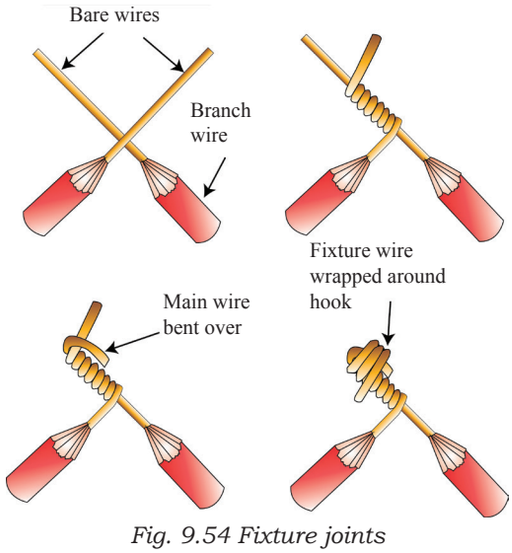

Fig. 9.54 Fixture joints

Know more...

Rattail joint splice, also known as 'twist splice', this joint is formed by taking two or more wires and wrapping them together symmetrically around the common axis of both the wires.

- Bend the branch wire over the completed turns.
- Wrap the remaining fixture wire over the bent branch wire.
- This can be followed by soldering and taping, or simply taping of the joint.

Knotted tap joint

It is used to connect a branch wire to the main wire as shown in Fig. 9.55. To form a knotted tap joint, the following points have to be considered.

- Remove about 1 inch of insulation from the main wire and about 3 inches from the branch wire.
- Place the branch wire behind the main wire so that three–fourth of its bare wire extends above the main wire.
- Bring a branch wire over the main wire. Then, turn the branch wire in a way that it forms a knot over the main wire. Wrap the branch wire around the main wire. Knots of the branch wire on the main wire should be short and tight. Trim the remaining terminal of the branch wire.

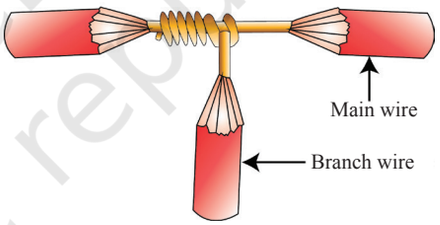

Fig. 9.55 Knotted tap joint

Joints using wire nut and split bolt

A wire nut replaces a rattail joint splice. The nut is, usually, housed in a plastic insulating casing. The process to make a joint using a wire nut and split bolt are as follows.

- Strip the conductors.
- Place the two wires to be joined into the wire nut.
- Twist and tighten the nut to form a joint.

Split bolt connector

A split bolt is used to joint large conductors as shown in Fig. 9.56. This replaces the knotted tap joint and

Fig. 9.56 Split bolt connector

can be used to join three ends or a branch wire with a continuous conductor. The bare wires are placed in the space between the two bolts, after which the nut is tightened to ensure a sound joint.

Crimping

Crimping refers to joining two metal pieces together. Generally, a wire and connector are connected together by deforming one of them, and enabling the other one to hold it. The resultant deformity is known as 'crimp'.

For crimping, do not use a pair of pliers as the deformity cannot be formed. If air is trapped between the crimp and the connector, it collects moisture. This eventually causes corrosion in the wire and can even lead to connection failure.

Crimping tool

Crimping tools are used for punching the connector on a metallic conductor. There are two types of crimping tool.

- Mechanical crimping tool
- Hydraulic crimping tool

Fig. 9.57 Mechanical crimping tool

Mechanical crimping tool

This tool (as shown in Fig. 9.57) is used for crimping wires. The diameter of a wire must range from 2.5 to 16mm.

Hydraulic crimping tool

This tool is used to crimp copper or aluminium cable lugs. Connectors can also be crimped onto the cable for cable connection. Cables having a diameter from 35 to 1000mm can be crimped as shown in Fig. 9.58.

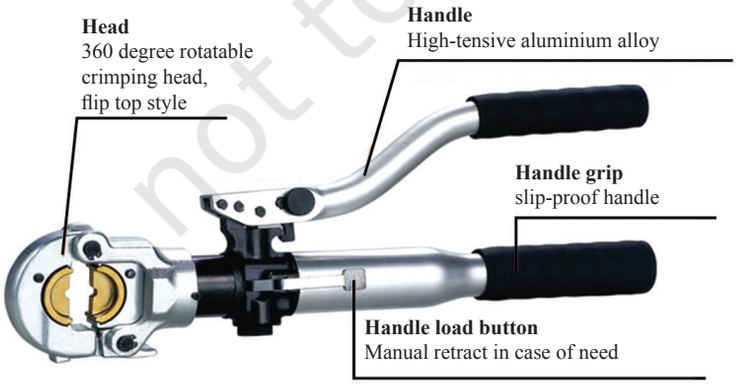

Fig. 9.58: Parts of a hydraulic crimping tool

Fig. 9.59 Different size of dies used in hydraulic crimping tool (diameter of 95–300mm)

Fig. 9.60 Fill oil in the hydraulic crimping tool

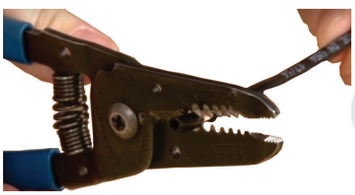

Fig. 9.61 Strip off the insulation

Fig. 9.62 Twist the conductor

Fig. 9.63 Connector connected into the wire

Die

A crimping tool die is designed for reliable and controllable electrical connection. Dies, which can be attached to a hydraulic crimping tool, are available in different sizes as shown in Fig. 9.59.

Care and maintenance

Cleaning: Dust, sand, environmental influences like high salt index, in particular, and dirt, in general, are harmful for hydraulic crimping tools. It is important to clean these tools carefully.

Storage: Appropriate storage is important to prevent damage to the tools because of dust, etc.

Checking the oil level: The oil level in hydraulic crimping tools must be checked at regular intervals. If it is not oiled for a long time, fill oil at the top end of the handle as shown in Fig. 9.60. While refilling, take some precautions, such as

- Use only the specified oil.
- Never use old oil.
- The oil must be clean and non-contaminated.

Steps of crimping

The steps of the crimping process are as follows.

Step 1

Strip the insulation of a wire as shown in Fig. 9.61.

Step 2

Make the tip of the wire firm by twisting the conductor material to enable better connection for the connector as shown in Fig. 9.62.

Step 3

Place the wire into the connector in such a way that the bare part of the wire touches the bare part of the connector as shown in the Fig. 9.63.

Step 4

Enter the wire along with the connector into the crimping tool.

Step 5

Squeeze the tool with force as shown in Fig. 9.64.

Step 6

After completion of the process, check that the wire and the connector are together even after applying force, as shown in Fig. 9.65. If you are able to pull off the connector from the wire, crimping has not been done properly.

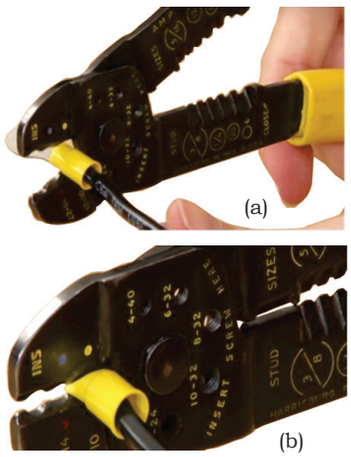

Fig. 9.64 (a and b) Squeeze the handle of the crimper to crimp the connector

Lug (Connector)

Lug (electrical connector) is an enclosure tied to an electric cable. It is used for supporting the connection of a cable. Lug is made of aluminium or copper. It helps tighten the connection. It is a solderless electrical connection. Lugs are punched on to the cable using crimping tools as shown in Fig. 9.66.

Fig. 9.65 Wire after crimping

Cable preparation

- Select appropriate pressing dies for the (connector) lugs to be crimped.
- The size of the dies varies from 35 to 400 mm diameter as shown in the Fig. 9.67.
- Insert the dies in the tool head. Half circled pressing dies are used in crimping. A half circled die is made of two parts with identical external measurements, so that they can be inserted into the piston or the head.
- The step for inserting pressing dies is identical to the mounting of both piston and head.
- The dies are inserted via guides until they come to a stop at the blocking pin.
- Then, the pin is retracted using the release button and the die is inserted further until it is held by the pin and is in place.
- When inserting into the piston, one must ensure that the crimper push button is pushed far enough forward for the release button to be visible and accessible.

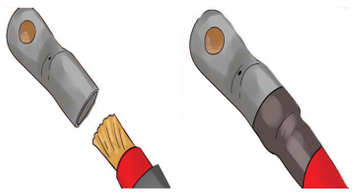

Fig. 9.66 Lugs connecting to the wire

Fig. 9.67 Dies of various size

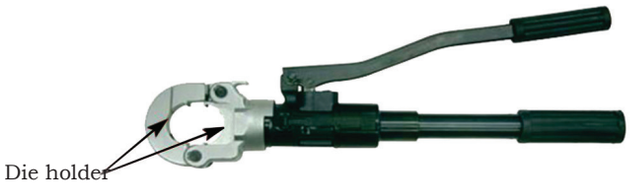

Fig. 9.68 Hydraulic crimping tool

- To remove the dies, in both instances, the relevant release button must be activated. Then, allow the dies to slide out. To remove the inserts at the piston, the steps listed above must be carried out in reverse order. A hydraulic crimping tool is shown in Fig. 9.68

Start

- Bring the tool to working position.
- Select appropriate pressing dies for the connector (lugs) to be crimped.
- Insert the pressing dies in the tool head.
- Insert the conductor into the connector.
- Place the connector firmly between the two pressing dies.
- Hold the tool securely and press the mobile lever arm to move the piston forward quickly until the pressing dies meet the connector to be compressed.

Fig. 9.69 Fixing the dies in crimper

Fig. 9.70 Inserting the cable into the crimper

Fig. 9.71 Pressing the crimper

Fig. 9.72 Crimped cable with crimper

Fig. 9.73 Dies removed from crimper

- As soon as the pressing dies start to compress the connectors, the system automatically switches from closing to working feed.
- Press until the pressure limiter can be heard or the pressing dies meet and a perceptible discharge of the pump occurs.
- To bring the piston to its basic position, activate the release lever on the tool. Releasing the pressing dies, return the piston to the basic position.
- The above mentioned step can also be used during crimping if you have made an error in the selection of connector or die.

Coaxial cable

Stripping of a coaxial cable depends on the type of connectors. You need to adjust the slide of the cutter according to the type of the cable. You can also use a knife to strip a coaxial cable. Stripping of a coaxial cable is shown in Fig. 9.74.

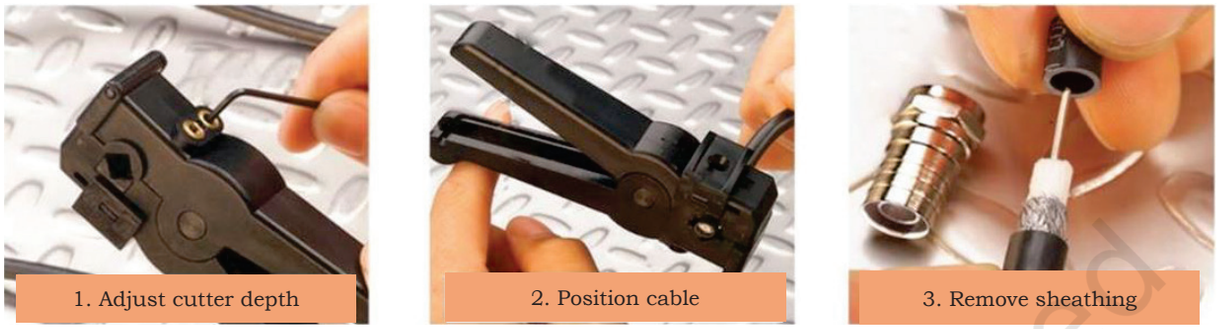

Fig. 9.74 Insulation stripping of a coaxial cable

Securing cables

For securing the cables, you need to ensure that

- the cables are supported in a way that they are not exposed to any mechanical strain.
- the termination of the cables must be free from undue mechanical strain.
- the cables are supported by appropriate means at regular distances to secure them from damage because of their own weight.
- clips are used to organise and group the cables.
- the hook and loop straps must be used to secure the cables (as shown in Fig. 9.75).
- the cable stress caused by tension in a tightly clinched bundle is minimised. Cable bindings for tying multiple cables must be irregularly spaced and loosely fitted so that it can be moved easily.
- the bends are made gradually while routing electrical cables. Sharp bends in the cable must be avoided.

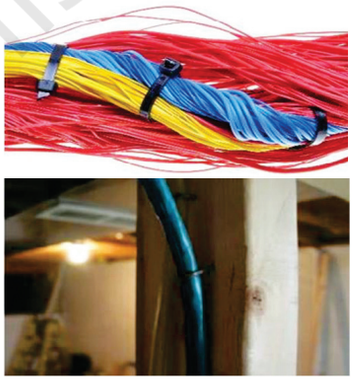

Fig. 9.75 Securing of cables

Preparing three-core cable

To prepare a three-core cable, the following steps must be considered.

- Remove the sheathing and wiring armour.

- Separate the wire armour and bend the wires away from the cable. Place a support ring under the armour at each side of the joint.
- Cut back the cable insulation.
- Remove the insulation from each conductor.

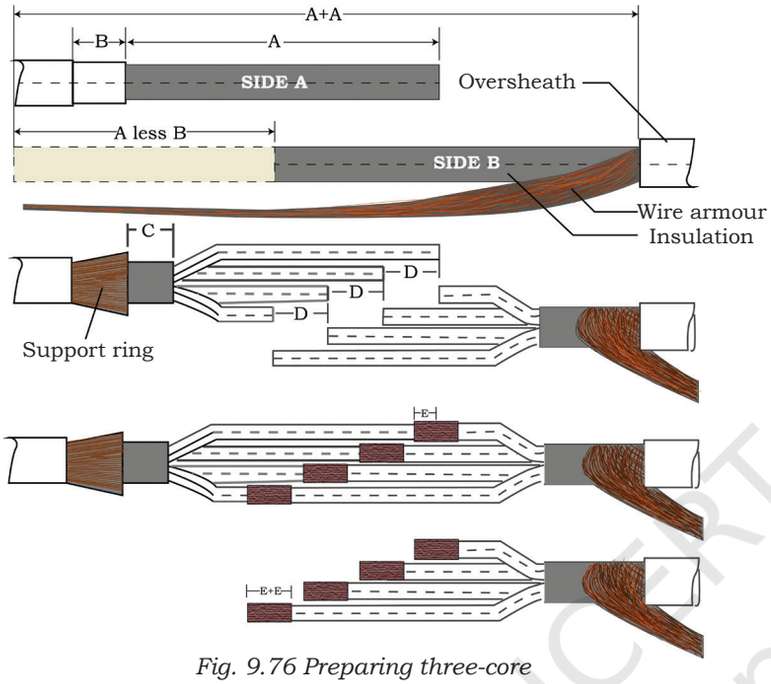

Fig. 9.76 Preparing three-core armoured cable

Crimping and insulating the cable

For crimping and insulating the cable, the following points must be considered (Fig. 9.76).

- Once the cable is ready, connect each end of the three conductors to a suitable mechanical connector or crimp.
- Tightly fix the matching connectors and test the connection.
- Tape the crimped connectors. Wrap around and extend to cover at least 25mm of the cable insulation of the conductor entering the connectors.

Binding the cables

Fig. 9.77 Taped, crimped connectors on individual cables

Bind the wires tightly, and then, tape them together. When insulating both individual cables and the whole bunch, fill in the voids to create even taped ends as shown in Fig. 9.77.

Restoring the armour and applying mesh tape

Fig. 9.78 Wires taped together

- Tightly wrap the cable from armour (metal covering) to armour while applying adequate tension around the insulation.
- Join the wire armour from one end to another and cut excess wire to the correct length. Ensure that the armour is spread evenly over the entire joint.

- Wrap the cable with mesh tape. Then, use standard vinyl/PVC tape to wrap over the mesh to provide mechanical barrier against stray wire ends. For the branch joint, bring both the main and branch cables together before wrapping. Next, use standard vinyl or PVC tape to wrap over the constant force springs placed over the under-armour rings. The tape provides a barrier against sharp edges as shown in Fig. 9.79.

Fig. 9.79 Wrapping the cable with mesh tape

Re-establishing the outer sheath

- Use a self-fusing tape to wrap over the cable and establish the outer sheath. Start in the centre and apply one layer of tape to one end, wrapping over the jacket for at least 25mm. Apply the tape from the end towards the centre so that you have two layers on each side.
- For branch joints, wrap over the insulation for both the main and branch cable by at least 50mm. Bring the two together and fill it with insulating putty from both sides. Do this up to 25 mm away from the point where the branch and main cables are joined.
- Put the two cables together and bind the main and branch cables tightly over the filling. Finally, wrap the crotch while pulling the branch away from the main cable as shown in Fig. 9.80.

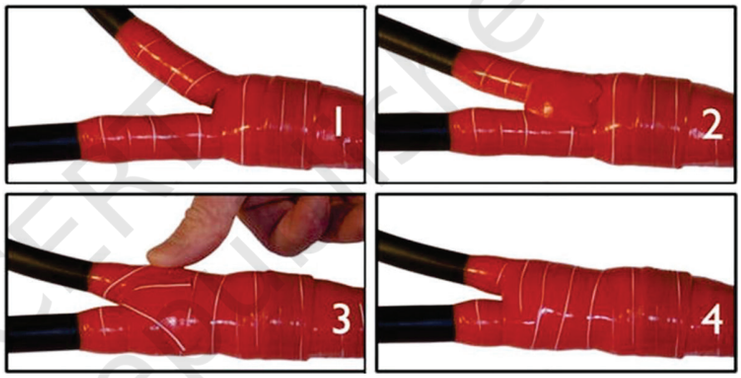

Fig. 9.80 Restoring the outer sheath on a branch joint

Check Your Progress

A. Multiple choice questions

1. Which of the following is used as electrical connector for an electric cable?
   (a) Lug
   (b) Plastic jacket
   (c) Clip
   (d) Tape

2. Which of the following tools is used for insulation removal in a coaxial cable?
   (a) Cutter
   (b) Stripper
   (c) Mechanical crimping tool
   (d) Hydraulic crimping tool
3. The size of dies varies from _____ to _____ diameter connectors.
   (a) 25 mm, 300 mm
   (b) 25 mm, 400 mm
   (c) 35 mm, 400 mm
   (d) 15 mm, 400 mm
4. Which of the following tools is required for crimping of a 70mm cable?
   (a) Mechanical crimping tool
   (b) Hydraulic crimping tool
   (c) Both (a) and (c)
   (d) Stripper
5. Which of the following tools require oil for its smooth operation?
   (a) Stripper
   (b) Hydraulic crimping tool
   (c) Plier
   (d) Cutter
6. Lugs are made of _____ and _____.
   (a) Aluminium and silver
   (b) Silver and copper
   (c) Copper and zinc
   (d) Aluminium and copper
7. Which of the following precautions must be taken while refilling oil in a hydraulic crimping tool?
   (a) Use only the specified oil
   (b) Never use old oil
   (c) Oil must be clean and non-contaminated
   (d) All of the above
8. Which of the following tools is used for wire bending?
   (a) Plier
   (b) Screwdriver
   (c) Stripper
   (d) Cutter
9. Which of the following tools is required for making noose (loop) in a wire?
   (a) Round nose plier
   (b) Cutter
   (c) Stripper
   (d) Hammer

10. Which of the following is not a type of joint?
    (a) Western union joint
    (b) Fixture joint
    (c) Knotted tap joint
    (d) Axial joint

B. Fill in the blanks

1. Insulation can be removed from an electric wire by using a _____.
2. Electrical connectors are called _____. These are used for crimping of electrical cables.
3. The oil level in a tank must be checked at regular intervals in _____.
4. Lugs are made of _____ and _____.
5. Non-adjustable stripping tool can be adjusted according to the length of the _____.
6. There is a spring in the cable clamp and the cutter can be adjusted according to the thickness of the _____.
7. The size of a wire must match the correct _____ of the stripper.
8. Lugs are punched onto a cable using _____ tool.
9. Clips are used for organising and _____ of cables.
10. Lugs are _____ connection.

C. State whether the following statements are True or False

1. Hook and loop straps must be used to secure the cables.
2. Lugs are made of zinc and iron.
3. The size of dies varies from 35 to 400mm diameter connectors.
4. Hydraulic crimping tools are used to crimp copper and aluminium cable lugs or connectors onto cables.
5. Crimping tool die is designed for reliable and controllable electrical connection.
6. A wire cutter is used for making markings on the wire.
7. Non-adjustable stripping tool can be adjusted according to the length of the strip.
8. Bends are made gradually while routing electrical cables. Sharp bends in the cable must be avoided.
9. Use standard vinyl or PVC tape to wrap over the armour rings.
10. Knives cannot be used for stripping of coaxial cable.

NOTES

D. Short answer questions

1. Write down the uses of a screwdriver and crimping tool.
2. What are the steps of crimping?
3. Write short notes on the following.
   - Hydraulic crimping tool
   - Die
   - Lug
4. What steps need to be taken for the care and maintenance of a hydraulic crimping tool?
5. Name the different type of joints used for cables.
6. List the steps for cable preparation.
7. What are the type of hand-operated strippers?